

Spring 96

WC Space
Tactics
Bulletin

Volume 3, Issue 2



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The Space Tactics Bulletin
Volume 3, Issue 2, Spring 1996

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The Space Tactics Bulletin is an official, non-directive SWC publication. Its purpose is to update warfighting staffs and units on SWC efforts to effectively employ space assets in support of operations, and provide a forum for information exchange to improve space tactics and procedures. The views and opinions expressed herein, unless otherwise specifically indicated, are those of the individual author. They do not purport to express the views of the Commander, Space Warfare Center; the Department of the Air Force, or any other department or agency of the United States Government.

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COMMANDER'S CORNER

There's an oft used expression that says "flexibility is the key to airpower". While I don't completely disagree, I think the true key to success is teamwork. In my first three months as the Space Warfare Center Commander, I have been impressed with the sense of teamwork exhibited, not only within the Center, but between the Center and its many suppliers and customers throughout the DoD, national, civil and commercial space communities. As we continue to explore new ways to exploit space systems to provide our warfighters the decisive advantage in combat, it is absolutely imperative that we continue to work as a team to ensure we get the best "bang for the buck" from space.

In this issue of the Space Tactics Bulletin, you will find many articles which highlight teamwork in action. Of particular note are several articles on the military use of commercial imagery products and an article on the Clark and Warfighter-1 multi - and hyperspectral imaging satellites. While these initiatives are still in the early phases of development the potential they have for influencing military operations is enormous. There are still many unresolved issues regarding dual military-civil use of these payloads, however, I'm convinced that the solid working relationships established to this point will ensure prompt resolution with mutual benefit to all team members.

One final note: As most of you know, Colonel Howard J. "Fryjack" Fry, Jr retired on 30 Jun 96 after 29 years of dedicated service. For the past two years Fryjack has worked tirelessly to support and guide the Space Warfare Center and to ensure that you, the warfighter, received the full benefits of our space capabilities. On behalf of the men and women of the Space Warfare Center and the warriors we support, I wish Fryjack the best of luck and Godspeed in his retirement.


GLEN W. MOORHEAD III
Brigadier General, USAF
Commander

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PROGRESS REPORT - GETTING “SPACE” TO WARFIGHTERS

Colonel Jack Fry, SWC/CV, DSN 560-9565

With increased technological advances, we will be able to equip the warfighter with smaller and more sophisticated “boxes” that will fit in their airframe or backpack to take more technology and information directly to the front line. It has become imperative that we tie this additional information together so that the soldier, sailor, and airman can access the same battlefield “big picture.” Space will be the primary medium that allows us to tie these new systems together – globally. The exploitation of space presents almost limitless potential to shape the battle (not just the battlefield) to our advantage. The Space Warfare Center (SWC) is working very hard to deliver new applications of space power to the Air Force. The following are some examples of our endeavors.

One of the problems US troops encountered during Operation DESERT STORM was pinpointing the location of downed aviators due to the featureless terrain. As a result, the TALON HOOK program was initiated to determine whether space systems could enhance the search and rescue mission by providing timely and accurate position information on downed aircrew members to combat search and rescue (CSAR) forces. The resulting HOOK-112 survival radio is a step towards locating downed aviators more quickly. Preliminary findings indicated that HOOK-112 provides significant improvements to the present day CSAR mission. The O’Grady shoot down and after-action reviews significantly spedup the HOOK-112 procurement effort. AF Tactical Exploitation of National Capabilities (AFTENCAP), the prime developer of HOOK-112, continues to work the transition of this capability to the field.

In addition to the research being conducted through the TALON HOOK program, the SWC continues to investigate multi-spectral imagery (MSI) technology applications to improve combat support to the warfighter. The SWC uses MSI as a means of providing space-based technology to mission planners, aircrews, and intelligence analysts. MSI normally uses unclassified, commercially available imagery that can be manipulated to provide wide area coverage of potential targets, landing zones, or drop sites. MSI data provides information from the visible light and infrared spectrum. The comparison of image data in different spectral bands permits materials not recognizable by human vision to be differentiated. MSI, by using multiple spectral bands, can provide detection and limited identification capabilities that and radar systems cannot. Analysts supporting airdrops can determine the degree of terrain slope and the type of soil and foliage in the target drop zone. In addition, they can detect camouflage, concealment, and deception efforts and update maps and charts using change detection analysis.

Communications is one of the hottest and most critical areas of space support to the warfighter. One specific example is the military application of digital broadcast technologies known as the Global Broadcast Service (GBS). GBS uses the latest phased-array antenna technology and focuses on fixed or mobile users who can use small (18 inch to 3 foot) dishes. GBS will provide DoD users with capability similar to the commercial Direct Broadcast System (DBS). GBS, which will soon be on-line, will radically increase our ability to move information. It will provide the warfighter with critical products, such as imagery, weather, unmanned aerial vehicle (UAV) video, threat avoidance and targeting data, and air tasking orders (ATOs). To put this capability into perspective, during Operation Desert Storm the standard ATO was 500 pages, and it took hours to transmit over normal communication lines. With GBS, this same ATO could be transmitted in less than one second. This would free up communication lines for other purposes. The SWC tested this concept during the Joint Warrior Interoperability Demonstration 1995 (JWID 95). Threat information, target imagery, and live UAV video were sent to multiple locations. These products provided information which directly affected mission execution.

The SWC is helping develop and find better ways to exploit space systems so that every combat element is not only on the same sheet of music, but on the same beat. Space holds many of the answers to meet the needs of the modern warfighter, but the exploitation of space assets and proper dissemination of space products remains a serious challenge. The SWC is continuing to incorporate space assets and information into warfighter exercises and real world operations.

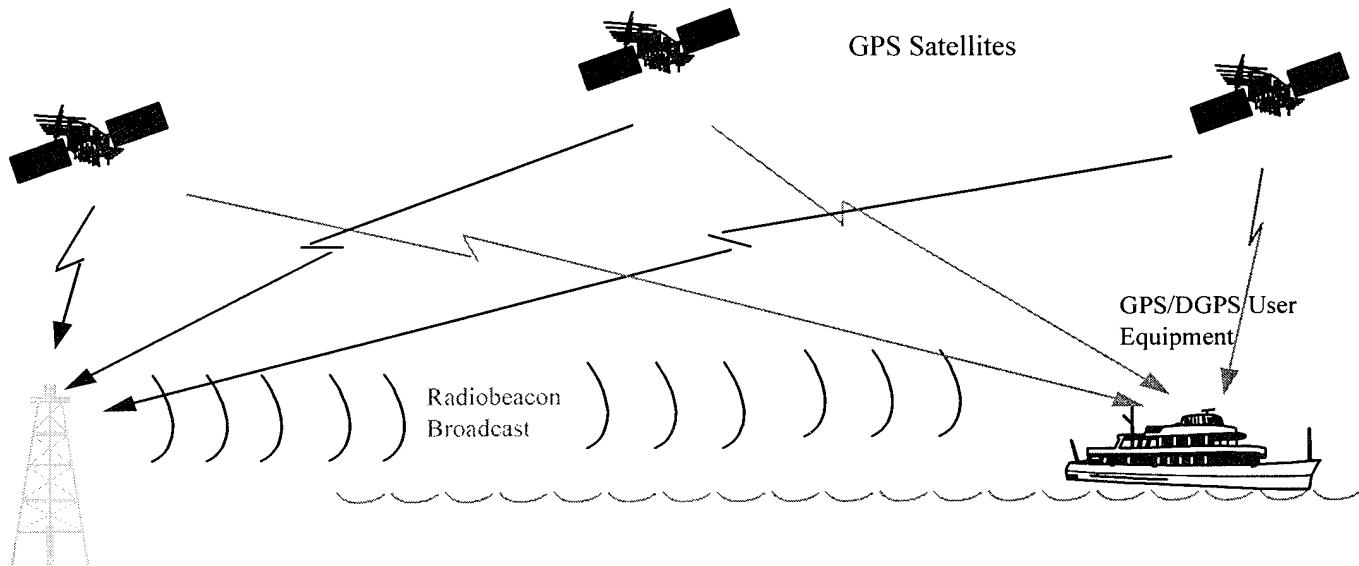
U.S. COAST GUARD DIFFERENTIAL GPS GOES INITIAL OPERATING CAPABILITY (IOC)

QMCS Walter Fontaine, US Coast Guard Liaison, HQ AFSPC/DOOS, DSN 692-3582

On 30 Jan 96, the U.S. Coast Guard declared Initial Operating Capability (IOC) for public use of the Differential Global Positioning System (DGPS) in United States harbor and harbor approach areas. The Great Lakes, Puerto Rico, and most of Alaska and Hawaii will also be covered. The DGPS signals will be broadcast via USCG marine radio beacons.

DGPS is the regular Global Positioning System (GPS) signal with an added correction (differential) signal that improves the accuracy of GPS. DGPS computes the GPS determined position of a reference station and compares it to its surveyed geodetic position. Then, the differential information (some systems use fix position errors while others use individual satellite range errors) is transmitted to the user's receiver by radio or other means. This signal can be broadcast over any authorized communication channel.

DGPS accuracy and integrity are better than GPS. Accuracy improvement (2drms): 10 meters or better for DGPS (USCG signals) vs 100 meters or better for GPS Standard Positioning Service (SPS). Integrity improvement: provides an independent check of each GPS satellite's signal and reports to the DGPS receiver whether it is good or bad.



DGPS receivers collect navigational signals from all satellites in view as well as differential corrections from a DGPS station in the area. Many DGPS receivers consist of two units: a GPS receiver with a data "port" for DGPS corrections and a radio receiver to which it is directly connected. DGPS receivers display position, velocity, time, etc., as needed for marine, terrestrial, or aeronautical applications. DGPS uses pseudorange corrections that are broadcast over the existing network of marine radio beacons in the Radio Technical Commission Maritime (RTCM) SC104 Version 2.1 data format. This SC104 format is very similar to the GPS navigation message and uses the GPS parity algorithm; however, the SC104 uses variable length messages instead of a fixed length message.

The Coast Guard DGPS is flexible, providing signals that marine, land, and air GPS users can use. In addition, DGPS supports three-dimensional (3D) solutions and can be modified to satisfy the requirements of other users as they are identified.

COLLECTION MANAGEMENT SUPPORT TO THE WARFIGHTER

IS3 Brett Folkert, HQ NORAD-USSPACECOM/J2OC, DSN 692-8522

NORAD/USSPACECOM's Collection Management Branch, N/SPJ2OC, supports a variety of NORAD/USSPACECOM as well as Air Force, Army, and Navy space component missions, ranging from strategic ballistic missile warning to the monitoring of foreign space launches. If you have an intelligence information requirement that the command plans and resources manager (SPJ2X) cannot satisfy, collection management is the office that will handle the submission, tasking, and collection of your requirement.

The first step in this collection process is to take your request for intelligence information to your command's J2 plans and resources division. They will attempt to satisfy the request with existing information. Then, if they determine there is no existing information to satisfy the request, they will forward the request to the command's collection management shop. This is the point where your request enters the collection pipeline. Collections will handle your requirement from the moment it comes through their door until the time the collected information is relayed to you. Accessing the existing national and theater-level collections tasking process is best handled by your local collection management shop; they know the procedures for submitting a requirement, and they have experience acting as both advocate and judge of the command's past requirements. To better understand collection management's role, let's see how a collection requirement is actually processed.

An intelligence requirement starts as a request for intelligence information from a consumer (warfighter, analyst, operator, etc.) within the command or its components. When making this request, the consumer should specify why this information is needed and how their mission objectives will be affected if the request is not satisfied. The consumer must be able to answer who or what is to be collected, and where or when collection should occur. It is the collection manager's job to determine exactly how the collection can be accomplished.

The consumer must justify the request for several reasons. One is to ensure the collection manager adequately understands what the consumer is trying to accomplish with the request. In addition, there is a limited number of assets and sensors to satisfy the multitude of consumer requirements competing for their use; therefore, the collection manager must determine the validity of individual information requests.

Once collections understands the consumer's request and determines that it is valid, they will search existing collection requirements to see if information that satisfies the request is already available. This streamlines the collection tasking process and prevents duplication of effort. At this point, the information request is out of the consumer's hands. The collection manager uses a dedicated computer system to draft the consumer's request in the correct format for submission to the appropriate asset for eventual tasking. If a national asset is required to satisfy a requirement, collections coordinates with Defense Intelligence Agency (DIA) to ensure that they understand the request and that it is appropriate. Next, DIA presents the USSPACECOM requirement to a national committee that decides whether or not to validate the requirement, based primarily on its justification and priority. If the national community validates the requirement, it is forwarded to the appropriate national agency for tasking/collection.

After the information is collected, it is sent back to the original requester, either to the collection management shop or directly to the consumer. As a final step, collections checks back with the consumer to make sure the information need was satisfied.

Collection management is the interface between national/theater tasking and the consumer. Collection management exists to support its customers by satisfying their information requirements and ensuring that they receive information in a timely manner and usable format.

NEW TECHNOLOGY IN THE HANDS OF THE WARFIGHTER

Maj Jon Wicklund, HQ AFSPC/XPX, DSN 692-5039

Does multi-spectral and hyperspectral imagery have utility for the military? This question will be answered by the Integrated Space Technology Demonstration (ISTD) program which will integrate new and developing technologies into a "proof of concept" capability. This capability will then be taken to the field where the warfighter can apply it and evaluate it to determine its utility for the military.

The program is focusing on two separate but related efforts - the Clark satellite demonstration and Warfighter-1 payload. Clark is a \$50M NASA satellite with multi-spectral and panchromatic sensors that the Air Force has leveraged for only \$2.4M. Clark will use civil and commercial assets to demonstrate how system tasking, data processing, and information dissemination can be accomplished within the Theater Commander's decision cycle. Warfighter-1 will be a military hyperspectral payload placed on board a commercial satellite. The draft Request for Proposal was released to industry in April 96.

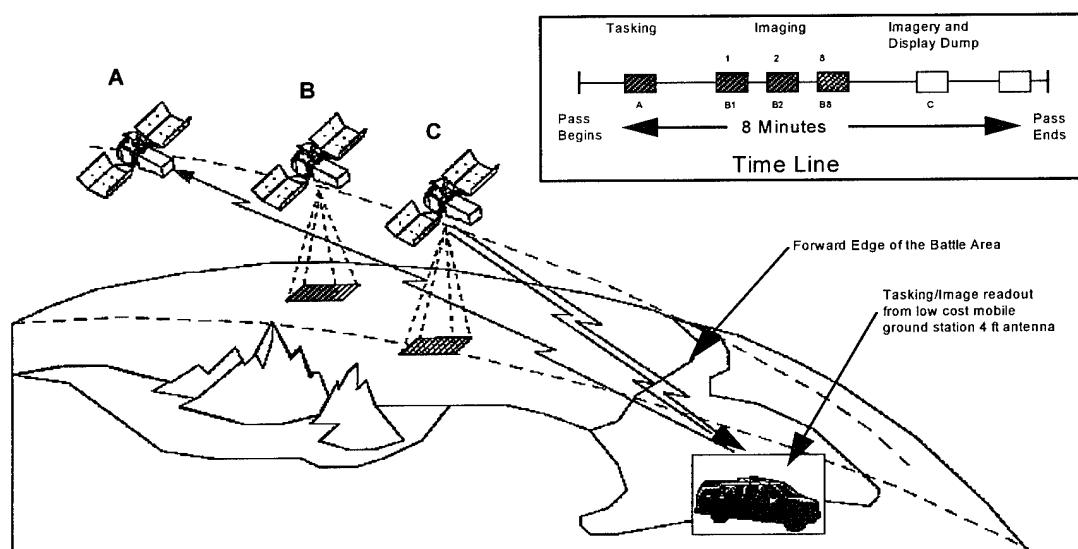
Clark Satellite

The Clark satellite will deliver high resolution imagery directly to the field via a mobile ground station. The mobile ground station is capable of commanding (uplinking) the imager and receiving (downlinking) mission data, consisting of unclassified visible and multi-spectral images, directly from the satellite. The ground station will process the images and then relay them to the warfighter in a usable format. This imagery can be used for mission planning, terrain mapping, target detection and location, and battle damage assessment.

The Air Force is performing this demonstration through an agreement with NASA to add an S-band transmitter to the Clark earth observing satellite, purchasing the mobile ground station, and providing training for the ground station operators. This agreement allows the Air Force to command the payload for 15 days a quarter.

The concept of operations:

- The ground station tasks the payload as it comes into view (A).
- A total of eight images (B) can be taken each pass. The targets to be imaged are designated by their latitude and longitude. The panchromatic (visible) sensor can image a 36 square kilometer area, and the multi-spectral sensor can image a 900 square kilometer area.
- Before the pass ends, the data is transmitted to the mobile ground station (C).
- Approximately one hour later, the processed imagery is in the hands of the warfighter.



The mobile ground station can be transported aboard a C-130. The fifteen-minute or less setup and teardown time allows for true mobile operations. Pentium/Windows NT hardware and software perform most of the data processing tasks, and ERDAS software enhances the raw imagery. The sensors will be able to:

- Identify vegetation type.
- Identify terrain type and moisture content.
- Detect camouflaged targets.
- Detect disturbed soil.

The planned launch date is 31 Aug 96, and the first military dedicated exercise could occur as early as late October. The Space Warfare Center and Phillips Laboratory are currently working with ACC, USAFE, the Navy, USSPACECOM, Army Space Command, and NATO to integrate Clark demonstration capabilities into scheduled exercises. Other interested warfighters should contact Capt Tyron Fisher, PL/SXD, DSN 246-6512 or Lt Col Darryl Herriges, SWC/XRV, DSN 560-9423.

Warfighter-1 Payload

The aim of Warfighter-1 is to be the "proof of concept" demonstration for the military's evaluation of the utility of hyperspectral imagery. Hyperspectral imagery can consist of several hundred bands. Targets that normally can hide or significantly camouflage their identity in a few bands (multi-spectral) cannot do so while being interrogated by a hyperspectral sensor. The Warfighter-1 payload will be a military payload on a commercial asset. The commercial vendor will provide the satellite and launch vehicles and perform payload integration, launch operations, and on-orbit operations. In return for these services, the vendor will be able to use the hyperspectral sensor in partnership with the military. The military user will be able to task the payload 12 hours a day or more.

GLOBAL BROADCAST SERVICE — "SPIN-ON" TECHNOLOGY

Richard Mock, HQ AFSPC/SCZP, DSN 692-3150

In the past, the commercial marketplace has capitalized on DoD funded advances in technology. For example, the KC-135 tanker developed by Boeing for the Air Force became the 707 airliner which dominated commercial air travel for decades. Now that times have changed and the military no longer has venture capital, the DoD is looking to turn the tables and capitalize on commercial R&D expenditures. The commercial direct broadcast satellite entertainment industry provides such an opportunity for DoD.

The April 1992 report to Congress on the conduct of the Persian Gulf War highlighted the limited ability of current military and commercial satellite communications systems to provide responsive, high-capacity communications to deployed, mobile tactical units. Recently, the Defense Science Board advocated using direct broadcast satellite technology to eliminate this limitation. The resulting program has been dubbed the Global Broadcast Service (GBS).

Current satellite broadcasting technology uses satellite-based transponders that communicate with individual users via terminals with 18-inch (TV) or 24-inch (data) antennas. GBS applies this technology to meet the DoD requirement for high-volume information transfer to the warfighter. These broadcasts enable timely delivery of large data file products to small, easily transported, and affordable tactical terminals. Given the small size of the receivers and their affordable commercial design, the system can be deployed to more users at lower command levels than previously possible. Although existing commercial equipment would have to be modified to meet DoD requirements throughout the world, the 1995 Joint Warrior Interoperability Demonstration (JWID-95) has

shown how this technology can be used for military purposes.

GBS will be a system of information sources, uplink sites, broadcast satellites, and receiver terminals, as well as management processes for requesting and coordinating the distribution of information products (see Figure 1). Each GBS satellite in a global constellation will be served by a primary uplink site where information products will be assembled and transmitted to a high-powered satellite for relay over a large geographic area. In addition, GBS will have the capability to take products from the theater it serves and inject them directly to the satellite for broadcast throughout the theater. While some of the receivers are large, what makes GBS so attractive is its ability to provide high volume data directly into very small antennas. Mobile force elements will no longer be restricted to working with large, fixed antennas, and they will be able to receive information formerly relegated to command centers. Since GBS enables the storage, retrieval, and dissemination of huge information files, which otherwise would quickly exceed the capability of most mobile users, tailoring the “push and pull” dissemination architecture for GBS presents a significant challenge. A user can not request information directly through GBS. Instead, the user must request the needed information (“user pull”) using other communications means.

GBS will be implemented using a three-phased approach that will provide the greatest capability as soon as possible and will expand to meet growing needs in a measurable, affordable manner.

Phase 1 – Limited Demonstration (FY96 - FY98). The focus of Phase 1 is to acquire limited off-the-shelf commercial capability and use it to support selected exercises and concept development.

Phase 2 – Interim Military Satellite Capability (FY98 - FY00+). During Phase 2, GBS packages will be placed on UHF Follow-on (UFO) satellites 8, 9, and 10, and user terminals and information management systems will be acquired.

Phase 3 – Objective System (FY99 - FY01). In Phase 3, GBS will achieve objective capability and complete the acquisition of space, ground, and user segments.

Military use of commercial technology is not a new practice, but it one that is gaining momentum as we look for ways to improve mission support while maximizing our scarce dollar resources. GBS looks to be a promising way to improve our warfighting capability at a relatively low cost.

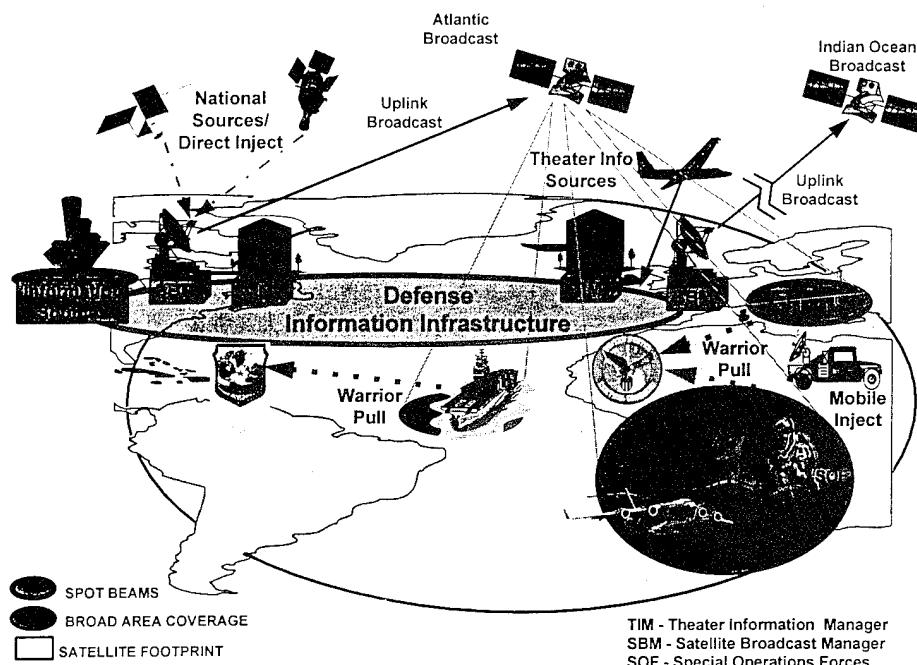


Figure 1 - Conceptual GBS Operations.

AIR FORCE SPACE SUPPORT TEAM

KEEPING PEACE AS PART OF JOINT ENDEAVOR

Maj Steven R. Serie, 76 SOPS/USAFE Flight CC, DSN 560-9845

1LT Mark Lester, 76 SOPS/USAFE Team Member, DSN 560-9072

Peacekeeping troops in Bosnia are experiencing a safer, more productive tour thanks to help from the USAFE Air Force Space Support Team (AFSST) deployed to Vicenza, Italy. Upon the request of **Lt Gen Ryan**, the Joint/Combined Forces Air Component Commander (J/CFACC) in charge of the air operations supporting the Implementation Forces (IFOR), the team deployed on 1 Dec 95 from the 76 Space Operations Squadron (home of the AFSSTs). IFOR operations began on 20 Dec 95 with the signing of the Dayton Peace Agreement. The air component operation is called OPERATION DECISIVE ENDEAVOR.

The USAFE AFSST has deployed to Italy several times in the past two years in support of NATO's OPERATION DENY FLIGHT and PROVIDE PROMISE, the precursors to OPERATION JOINT ENDEAVOR. OPERATION DENY FLIGHT was supported by almost 4500 personnel from 12 NATO countries. Its mission was threefold: (1) Conduct aerial monitoring and enforce compliance with UN Security Council's Resolution banning flight by fixed/rotary wing aircraft in Bosnia's "No-Fly Zone"; (2) Provide close air support (CAS) to UN troops on the ground; and (3) Conduct approved air strikes against those designated targets threatening the security of the UN-declared safe areas. AFSST support ranged from providing multi-spectral imagery products of drop zones generated by the Space Warfare Center (SWC), to writing space annexes for the peacekeeping operation, to trouble-shooting satellite communications and GPS problems at Vicenza and with the search and rescue forces at San Vito, Italy. These were heady times for the 76 SOPS. Although tasked to provide the support, the squadron had not been officially "stood-up." Fortunately, the theater recognized the manning problems, and thanks to augmentation from 14 AF and SWC personnel, 76 SOPS successfully completed their mission. **Lt Gen Ryan** put it best when he sent word back to **General Ashy** – "Your space team did a superb job....thanks for the help!"

As a result of the success of OPERATION DENY FLIGHT, **Lt Gen Ryan** requested beginning 1 Dec 95, a permanent AFSST presence to support OPERATION JOINT ENDEAVOR. 14 AF and the 76 SOPS rose to the challenge and stepped up their ops tempo to get a team in place as soon as possible. Upon notification from **Maj Gen Vesely**, 14 AF/CC, the team was readied, equipment packed, and both were on an airplane within 24 hours. The team was on the ground in NATO's Combined Air Operations Center (CAOC) at Vicenza's Dal Molin military airport the next day. The CAOC plans and executes air operations using aircraft from Aviano and San Vito airbases in Italy, Ramstein and Rhein Main airbases in Germany, and Taszar airbase in Hungary. The AFSST is 14 AF forward space warriors in the CAOC; and are the space "belly button" the CAOC Director. Their mission is to integrate space systems and corresponding applications correctly and efficiently into NATO's air operations supporting IFOR.

Until recently, space, and the Air Force in general, has had limited experience supporting peacekeeping operations. Currently, the team in Italy is having to redefine the "playbook" – sometimes on the fly. The key to applying space to peacekeeping operations "correctly and efficiently" is a proactive attitude and a flexible mindset that can adjust to this new military mission. Because the US now operates with NATO allies, as well as Russian and eastern bloc "friends," the team has quickly realized support to peacekeeping operations will have to be adjusted to account for this new paradigm. As a starting point, they looked back on experiences supporting combat operations and exercises and assistance received from the 14 AF/SOC (our reachback to the AFSPC "brain-trust"), and selected those nuggets applicable to the peacekeeping mission. For the most part, these nuggets were from "blue" space systems. The team's focus is ensuring that the space systems are providing the required support to NATO forces and aircraft. Since the threat from former "red" space systems is practically non-existent, it is not necessary to concentrate in this area.

The deployed team, which consisting of two crewmembers rotated every 6 weeks, providing support and

expertise in navigation, communications, weather, and multi-spectral imagery. They provide two services on a daily basis: GPS accuracy predictions in the Air Tasking Message (ATM) and an HF propagation forecast. The ATM is the NATO equivalent to the US Air Tasking Order (the plan all aircraft use to fly their sorties). GPS accuracy varies on a daily basis, and this variance affects each air mission differently. Using OMEGA (Operational Model to Exploit GPS Accuracy), a 76 SOPS-developed computer program loaded on their laptop, the team is able to predict daily GPS accuracies. They take the GPS almanac received on their Precision Lightweight GPS Receiver (PLGR), port the information into their laptop, run the OMEGA program, and output the accuracy variances into the ATM. Squadron tactics shops with GPS-equipped aircraft use the information for mission planning. These aircraft (mainly from Rhein Main and Ramstein airbases in Germany) are C-130, C-141, and C-17 airlifters, AIRMEDEVAC C-9s, and JSTARS aircraft. The combat search and rescue AC-130s and MC-130s at San Vito, Italy, also use the information. For the second service, the HF propagation forecast, the team is taking the 50th Weather Squadron's atmospheric anomaly forecast and tailoring it for the in-theater HF users. The Airborne Command & Control (ABCCC), AIRMEDEVAC, and the United Kingdom's AWACS aircraft can now plan for usable HF frequencies, instead of dialing up and down the spectrum until they find one that works.

In addition to daily duties, the team uses their Theater Support Operations Cell/Space Information Terminal (TSOC/SPIT) to monitor the blue space order of battle, as well as the status and coverage of each satellite supporting OPERATION JOINT ENDEAVOR. They helped the C6 solve satellite communications problems with the central command and control (C²) net (called the air operations net), and assisted the Special Operations Forces weather personnel when they had a critical shortfall receiving polar orbiting satellite weather information. One of the team's biggest successes has been helping the J/CFACC with multi-spectral imagery products. Once again **Lt Gen Ryan** put it best: "Outstanding...this is another valuable piece to the puzzle...I'll take this to Adm Smith in Sarajevo tomorrow!" The team is developing innovative ways to apply space in support of peacekeeping operations – "You gotta be there to capitalize on the opportunities."

Since 1 Dec 95, the following AFSST personnel have deployed to Vincenza: Lt Col Brazeau, Maj Davies, Maj Moore, Maj Reynolds, Maj Serie, Capt Klein, Capt Smith, Capt Vogen, Lt Lester, and MSgt Marks. Peacekeeping operations are scheduled to last through Dec 96, and the plan is for all 76 SOPS personnel to rotate through Vicenza to gain valuable real-world experience. The 76 SOPS solicits innovative ideas to execute this exciting mission in support of peacekeeping operations. If you have a requirement to go in-theater, let us know – it's our job to help you hookup with the right people to ensure efficient operations. Call anytime – come exercise or operate with us. In the spirit of our heritage with the original Flying Tigers Squadron of WWII fame – "Ding Hao!"



KEEN EDGE 96

Maj Michael Stroud, 76SOPS/DOOA DSN 560-9698

Headline News - The Latest on the War in Japan:

Enemy ground troops have invaded the island of Hokkaido. Meanwhile, scuds continue to hit Hokkaido and the northern tip of Honshu, Japan's main island. The Japanese Self-Defense Forces (JASDF) and U.S. Forces Japan (USFJ) are trying to regain air superiority but are meeting a significant air and surface-to-air threat. Search And Rescue (SAR) teams are busy trying to recover the many downed American and Japanese fliers. The capabilities and resolve of the enemy forces have surprised the Japanese and American forces.

Fortunately, this is not a real world conflict, but the exercise scenario for Keen Edge 96, a bi-annual JASDF and USFJ exercise that took place from 25 Jan to 2 Feb 96. The exercise pitted friendly forces against Orangeland, a notional enemy with capabilities similar to the Former Soviet Union, whose latest generation weaponry provided a significant challenge for the exercise participants. For the 76th SOPS, it was a unique opportunity for the PACAF Air Force Space Support Team (AFSST) to continue their integration into Pacific Command's Numbered Air Forces.

Keen Edge 96 was unique in that, for the first time, the Air Operations Center was in two different locations. The AFSST supported Combat Plans at Yokota Air Base and Combat Operations at Fuchu Air Station. The team chief, Lt Col Craig Brazeau, briefed the Joint Forces Air Component Commander (JFACC), Major General Swope, and his Japanese counterparts daily. This briefing covered the status of space systems and kept the commander informed on 14th AF's ability to continue supporting theater operations. With MSgt Ken Frankovich and TSgt Bill Byrns providing 24-hour support, the team maintained a constant presence in Combat Operations, offering space solutions to the warfighter's problems. Maj Mike Stroud, the final member of the team, worked with Combat Plans to ensure the next day's Air Tasking Order took full advantage of space capabilities. The team provided exercise players with a daily "Inputs from Space" letter including printouts showing Global Positioning System accuracy, friendly and enemy satellite coverage, and other significant space events.

Educating the warfighter is a key part of the AFSST's exercise activities. The team gave numerous briefings covering the AFSST mission, Theater Missile Defense (TMD), multi-spectral imagery, TENCAP projects, and the capabilities of the team's Theater Support Operations Cell. In addition, the team received inputs from the exercise participants to determine how to best provide space support to them in the future. Despite initial planning that limited space play, the interaction between the AFSST, JFACC, and other players made space a significant part of Keen Edge. An important result of this exercise was many exercise participants began to view space as a normal part of their planning and operations.

Headline News – Update on the Situation in Japan:

Orange forces are being pushed back on all fronts. Tactical deception plans based on space inputs caught enemy forces off-guard. TMD operations continue to reduce the number of Scud attacks and provide early warning for any missiles that make it past the formidable Patriot coverage. SAR forces continue to recover aircrews with help from space-based resources. Meanwhile, improved intelligence on enemy positions is decreasing the number of downed aircrews. Offensive air operations, aided by the latest target imagery, are taking their toll on Orange forces. Orangeland's surrender is imminent.

MANAGING THE FLOW OF COMBAT INTELLIGENCE INFORMATION: CORRELATORS AND THE WARFIGHTER

Maj Mark Wilbanks, SWC/DOZ, DSN 560-9151

LCDR Phil Tinsley, SWC/DOZ, DSN 560-9878

A correlator is a computer-based system taking high volume intelligence information feeds from multiple sources and translates information into a meaningful format for combatants throughout the chain of command. The rate of combined feeds from aircraft, spaceborne assets, intelligence databases, and National assets converge on a command and control center routinely exceed the equivalent of 1000 pages of text per second. Without correlators, finding needed intelligence information would be like reading every book in a library hoping to find one applicable paragraph. For example, an AWACS controller employs one method of correlation filtering the air radar picture by selecting only targets with a velocity greater than a chosen value. Without this filter criteria, the AWACS radar screen would show flocks of birds, clouds, cars and other irrelevant information (see Figure 1a). On the other hand, a Joint STARS aircraft radar operator selecting targets with a velocity less than this value would receive a realistic ground radar picture. However, filtering is just the start of the correlation process. Correlated data has value to the warfighter only after information that accurately portrays identity, intent, and capability is attached to returns. PROJECT CORRELATION is examining the ability of tactical data broadcast systems to perform this attachment. The correlation product is then categorized based on its usefulness and timeliness.

Current research efforts to improve data correlation have focused on message and track data correlation. Messages report events such as emitter location or SCUD missile launches. One critical goal of message correlation is to verify conflicting information or resolve multiple reports of an event by different sensors. For example, message correlation could be applied to verify if five different intelligence sources reporting a SCUD missile launch are reporting the same event, refined estimates of the event, or multiple launches. Track data is used to establish the current and past position of objects; however, it becomes difficult to track objects when they are close together and maneuvering. For example, in a 4 versus 4 dogfight, an AWACS controller may be able to clearly identify the individual aircraft before they merge in a one turn fight; however, after they separate, some track correlation is necessary to determine who is who.

Correlating track and message data is one way to solve track identification problems. A viable solution would be one in which each track has associated intelligence message tags providing a unique fingerprint for that object. Aircraft tags might contain pilot speech identification (e.g., Middle East accent from an airline transmission), information on airfield of origination, infrared data, airframe vibrational modes from radar returns, and Identification Friend or Foe (IFF) transponder emissions. The correlation process attempts to match tags with tracks. One of the goals of PROJECT CORRELATION is to ensure that correlation is reliable and automatic, so that operators will not have to match tags to tracks.

If track and tag data were complete and accurate, it would be simple to develop computer-based schemes to correlate the two types of data. Unfortunately, every observation has a probability of error. Due to noise, atmospheric attenuation, and proforma (machine to machine digital communications) connectivity errors, correlation sites receive intelligence feeds with missing data. As a result, the information might not be correlated immediately. A complete data set with a high probability of error could be worse than an accurate but incomplete data set. An example of an incomplete data set is an IR return without range information or a radar return without azimuth information. These incomplete observations must be either discarded or matched with future observations. Determining how long an observation will be relevant in the correlation process before it begins to corrupt that process presents an ongoing challenge.

Dr. Aubrey Poore of Colorado State University at Fort Collins is doing pioneering research on incomplete track data and tracking schemes. He plays a statistically complex computer game of connect the dots on a radar screen. One technique he uses, called Multiple Hypothesis Tracking, follows the possible paths an aircraft may

have taken, then rules out all but one track as (hopefully) relevant feeds arrive. A common example of this would be radar tracks of an F-15 chasing an adversary who momentarily disappears behind a ridge line. After the two tracks emerge from behind the ridge, there are two possible solutions (hypotheses) for which aircraft is on which track line. Virtually any tag, such as a radar cross section, velocity, or infrared signature denoting the number of engines, could be used to rule out the incorrect hypothesis (see Figure 1b and 1c).

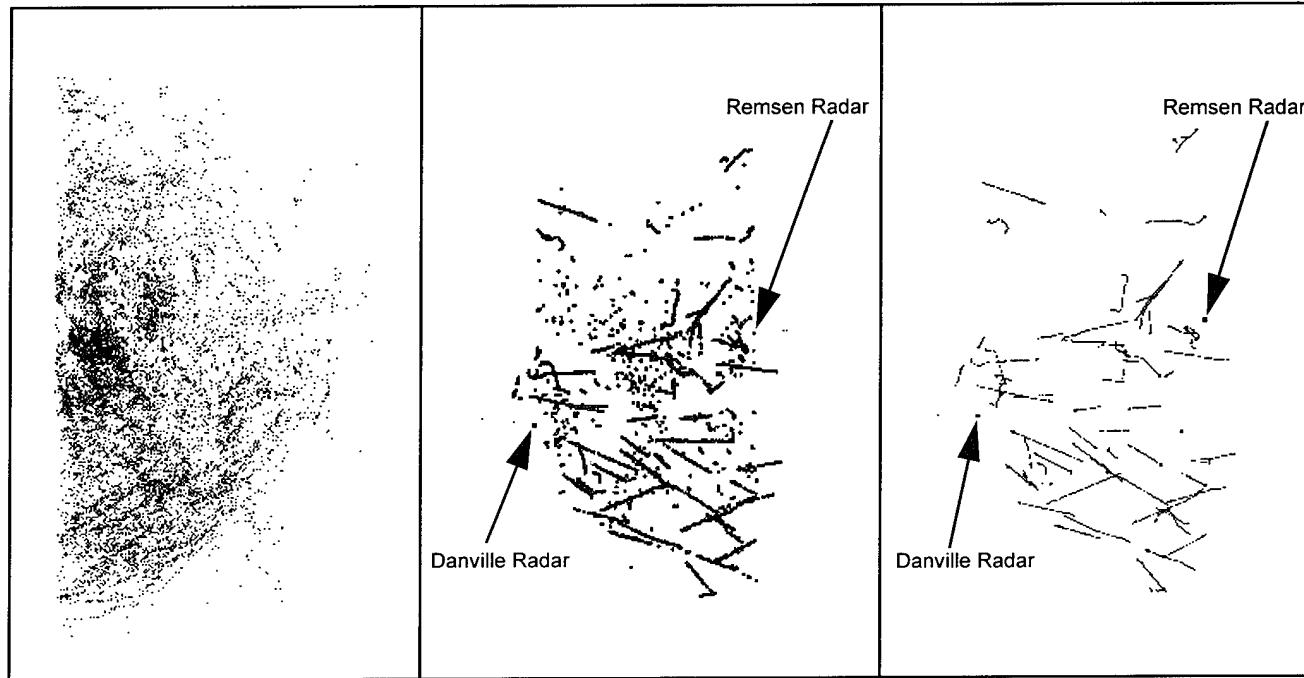


Figure 1a

Figure 1b

Figure 1c

Figure 1a - Half the field of view of an AWACS radar after 40 Scans

Figure 1b - Unprocessed radar returns from the Dansville and Remsen Radars

Figure 1c - Track lines after using an algorithm developed by Dr. Poore on the data of Figure 1b

PROJECT CORRELATION will produce a report categorizing all deployed intelligence collection systems (over 300) using one or more of the 35 existing correlators. Although they might share common correlators, these systems use schemes tailored to specific mission profiles and, thus, are not compatible. PROJECT CORRELATION will evaluate the capabilities and flaws of each incompatible system, the ability to adapt correlators to changing mission requirements, and efficient methods of connecting systems to the world-wide communications network, known as the Global Command and Control System (GCCS).

The DoD is migrating to the GCCS-based architecture shown in Figure 2, where each intelligence collection system uses the Defense Information Infrastructure Common Operating Environment (DIICOE) standard to communicate with GCCS. DIICOE is an evolving hardware and software standard that intelligence collection systems will use to communicate through GCCS. Information on the standard can be found on the Internet at http://www.itsi.disa.mil/cfs/itsi_lib.html.

Global Command and Control System (GCCS)

GCCS is a Navy program administered by the Defense Information Systems Agency. POC is Capt Scott

Lewis, (703)607-6406. The GCCS home page, <http://spider.osfl.disa.mil>, provides a concise description of GCCS:

Mission: The Global Command and Control System (GCCS) is an automated information system designed to support deliberate and crisis planning with the use of an integrated set of analytic tools and the flexible data transfer capabilities. GCCS will become the single C⁴I system to support the warfighter from foxhole to command post.

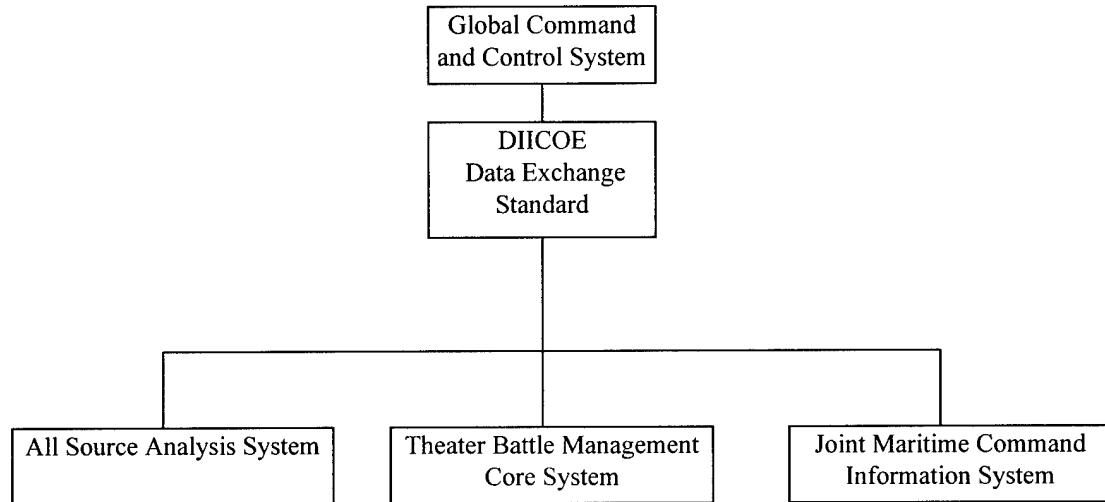


Figure 2 - DoD Intelligence Collection/Correlation Architecture

All Source Analysis System (ASAS)

ASAS, administered by the Army Program Executive Office for C³S, was established in 1993 and intended for use by ground based intelligence consumers. The program has 24 Army units as customers. The immediate goal of ASAS is full compliance with DIICOE. POC is Mr. Tom Noon, Technical Director ASAS, 1616 Anderson Road, McLean VA 22102, (703)275-8126.

Theater Battle Management Core System (TBMCS)

TBMCS is being developed by the Air Force Electronic Systems Center to serve the operations and intelligence needs of air combat. The system provides correlated air and ground intelligence products and complies with the DIICOE kernel. Level 5 DIICOE compliance for joint applications is planned for the next version release. POC is LtCol David Lambert, ESC/AVB, (617) 271-2409.

Joint Maritime Command Information System (JMCIS)

JMCIS correlates data up to the SCI level to provide operational commanders with a tactical view of enemy, friendly, and neutral forces. This Navy-wide C⁴I system is deployed on every combatant ship, at all shore command centers, and on some submarines. LCDR Rick Guerrero of Space and Naval Warfare Systems Command has spent five years integrating existing Navy C⁴I assets under JMCIS. JMCIS is compliant with the DIICOE standard. POC is LCDR Guerrero, Space and Naval Warfare Systems Command, Code PMW-171, 2451 Crystal Drive, Arlington, VA. 22245-5200, (703) 602-3748.

The intelligence community is debating whether there will be a single, multi-service intelligence collection/correlation system. Regardless of whether this occurs, the DoD has mandated collection systems be compatible with the architecture depicted in Figure 1. GCCS and future connectivity architectures will have a force multiplier

effect on existing collection systems. The synergistic effect of having existing sensors work together, rather than separately, will provide an accurate picture of the battlefield to the warfighter.

DATA FUSION AND THE WARFIGHTER

Mr. Ron Cole, US Space Command / NCR, DSN 692-3724

What is data fusion, and what should it mean for the warfighter?

Data fusion is the process of integrating data from different sensors or sources to produce the most specific and comprehensive information about an entity or event. For example, merging data from electronic intelligence (ELINT) and communications intelligence (COMINT) sources provides the best available characterization of the battlespace.

Correlation, on the other hand, is the process of integrating data from similar sensors or sources to improve the value or validity of the data. Correlation can be an input to the data fusion process. For example, ELINT from two similar sensors can be merged to better identify a specific threat emitter or to improve the continuity on a target track.

Normally, the products of the data fusion process address three “states” of information:

STATE I - Identity of an entity or event (existence, position, velocity, or location).

STATE II - Assessment of an event (behavior or situational awareness).

STATE III - Threat definition (intentions or force capabilities).

Properly produced data fusion products support political analysis, enemy intent, terrain reconnaissance, combat intelligence, and force capability assessments - all of which are needed to define the battlespace. The key to the utility of data fusion products is the producer must start with a clear understanding of what the warfighter needs, not just an understanding of what the sensors or sources can produce.

A central function of US space assets is to help warfighters understand their battlespace. Commanders require an integrated picture of the operations being conducted in their area of responsibility. They need a clear portrayal of enemy forces, intentions, and locations based on timely, relevant information in a format the warfighter can use. The value of the information increases if delivered as a data fusion product, rather than separate reports from multiple sources. It is highly possible warfighters will reach “cognitive overload” if, on an individual basis, they have to absorb the data produced by improved sensors and sources that are now monitoring advanced and changing threat systems. Therefore, the delivery of data fusion products must become common place, and the warfighter must use these products when training to be prepared to use them in a crisis.

JOINT EXERCISE SUPPORT

Dr Joe Melton, SWC/AE, DSN 560-9551

Air Force personnel are aware exercises are a part of peacetime training. Each of us has experienced security police rushing around base during their exercises looking for such threats as terrorists engaged in shady activities. While it is a distraction, we know it is imperative those who must respond to such activities in real time are properly trained to do so. On a larger scale, if the US or one of its allies was attacked with nuclear ballistic missiles, we would expect our leaders to have some idea on how to proceed. Commanders-in-Chief (CINCs) have their battle staffs to advise them during such crises. Battle staff members include representatives from J1 (Person-

nel), J2 (Intelligence), J3 (Operations), J4 (Logistics), J5 (Plans), and J6 (Communications). With proper training, these highly-trained men and women on the battle staff will be prepared to respond appropriately in the event of an actual attack; therefore, training them through exercises known as "Command Post Exercises" is of paramount importance.

The purpose of an exercise is to train and evaluate. Command Post Exercises occur throughout the year at different command levels such as NORAD, USSTRATCOM, and Joint Staff (JS). Each exercise is structured to train (test) the battle staff on one or several different objectives, including communications systems, logistics systems, space systems, etc.

The sponsor (JS, USSTRATCOM, NORAD, or a CINC) defines its major exercise objective, and then representatives from battle staff member organizations negotiate. Each representative has his or her own organizational objective and will try to get this integrated into what must be a single coherent set of events. For instance, it is the responsibility of USSPACECOM to ensure space is incorporated into the exercise by providing space support to the sponsoring command. During the negotiation process, the representatives define the events, determine who the bad guy is, and establish the timeline for the events. The events may include anything from an attack with a single rogue missile to a script involving an international crisis with a slow buildup of tensions culminating in a mass missile attack. The first event would play out in a few minutes, while the latter could take a couple of weeks. During either crisis situation, the battle staffs would be providing advice to their respective CINC as the events of the exercise unfold.

USSPACECOM/J33Z is the Command Exercise Authority, overseeing the development and execution of both Command Post and Field Post (a tactical exercise designed to train and evaluate those close to the theater of war) exercises. A USSPACECOM staff member will act as the Action Officer during exercise definition negotiations, coordinate the development of the events, ensure that all players are apprised of their roles, and guide the execution. After the exercise is completed, USSPACECOM/J33Z will review the actions taken by participants and compile the lessons learned.

One of the most important parts of an exercise is the generation of the events (conversion of exercise specifications to sensor messages). These events may be a script that is read during the execution of the exercise. For a larger scenario, computer tapes containing warning sensor information would be played and participants would discuss the developments as they appeared on their console screens.

The event data for exercises is generated in the Analysis and Engineering Directorate (AE) of the Space Warfare Center. SWC/AE and its precursor directorates have been performing this essential task for many years.

After receiving the specified requirements from J33Z, SWC analysts build the tapes containing those sensor messages normally generated during an actual attack. These messages are from Defense Support Program (DSP) satellites indicating missile launches and nuclear detonations and from ground radars providing Predicted Impact and Attack Assessment. The SWC/AE staff uses computer simulators on a DEC VAX 4000 computer and Silicon Graphics workstations to model missile trajectories from the attacking country to whatever targets the exercise sponsor desires. Next, they send the trajectories through sensor simulators which respond to the simulated trajectories just as the real missile warning systems would respond to real missiles. The output is a stream of messages from each ground radar and space sensor relaying information on missile origination, assessment of missile type, and estimated target and impact time. After these messages are merged, they are identical to those which would be sent to Cheyenne Mountain and USSTRATCOM during an attack, except for a single "1" instead of a "0" in a particular field to indicate "test."

The simulated messages are written to computer tapes sent to NORAD, USSTRATCOM, and others for further processing. Because NORAD uses Honeywell computers, USSTRATCOM uses UNISYS, and other commands use IBM, the VAX formats have to be changed on site to fit the unique requirements of the host computers. During the exercise, the tapes are played simultaneously at three facilities to simulate the events transpiring during an actual attack.

Once the tapes are built and delivered, SWC/AE's job is finished. They do not participate in the actual

exercise; however, after a preliminary run, they are frequently called upon to make modifications to the exercise. Playing out that which was conceived at a desk or around a table is often different on the screen from what the creators expected. Often more missiles are added, target strike order is changed, or deletions are made, and SWC/AE is tasked to make those changes.

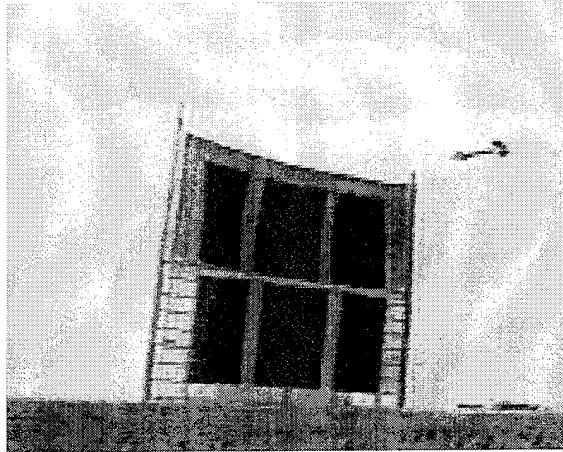
About a dozen of these Command Post Exercises are conducted throughout the year. A typical exercise from the Joint Staff will involve hundreds of government employees and often the Vice President of the United States. Of those hundreds of employees, some of the most important are quietly making their contribution from the Space Warfare Center.

WAGE GUIDES AGM-130 FROM LAUNCH TO TARGET

Capt Jeff Hills, SWC/DOZ, DSN 560-9632

On 24 February 1996, the Space Warfare Center (SWC), working with the AGM-130 program office, launched the first AGM-130 to be guided entirely by Wide Area Global Positioning System (GPS) Enhancement (WAGE) information. WAGE is a three-phase joint effort by the SWC, the Defense Mapping Agency, and the 50th Space Wing's 2d Space Operations Squadron to improve GPS navigation to better than 3 meter accuracy.

From its launch, 13 miles from its target at Eglin AFB, to its impact point, approximately 6 meters from the



designated aimpoint, the rocket-powered, 2000 pound bomb used only WAGE information for guidance. Normally, the Weapons System Operator (WSO) in the launch or controlling aircraft uses remote control to fly the AGM-130 into its target. The WSO follows a video display transmitted from the AGM-130 which is using a visible light or an imaging-infrared seeker. With WAGE guidance, the weapon has a true all-weather "launch and leave" capability.

Other WAGE weapons demonstrations are planned for the near future, including the LongShot® weapon adapter kit in April and a Conventional Air Launched Cruise Missile in August. The August demonstration should see even greater accuracy due to enhancements from WAGE phase II, in addition to the WAGE phase I used for this AGM-130 launch.

COMMERCIAL IMAGING SATELLITES

Capt Shane Smith, SWC/INA, DSN 560-9099

A new era for military imagery is about to begin. The EarlyBird satellite, the first U.S. commercial satellite licensed to image at three meter resolution, is scheduled to be launched late this year, and within the next two years, four US licensed commercial imaging satellites with one to three meter resolution should be in orbit. In addition, many other foreign systems with similar capabilities are scheduled for launch (see Figure 1). Because they are commercial ventures, their primary goal is to fill a niche in the commercial market for imaging products, while making a profit in the process. With this in mind, the United States Government (USG) is reviewing ways to leverage these systems to support government and military requirements.

There are numerous applications for this higher quality panchromatic and spectral imagery. First and foremost, one meter panchromatic imagery is good enough to use for military applications such as targeting, topographic studies, mission planning, and intelligence preparation of the battlefield. For example, a trained imagery interpreter can distinguish an F-15 from an F-16, and an untrained person should be able to differentiate fighters from bombers. Although we may not want to task commercial satellites to gather information on high value point targets, there are other opportunities. For instance, these systems could be used to cover broad search areas which would free up national and theater assets for targets, help identify military activity that might have gone unnoticed, and cue other systems to get high quality coverage if necessary. Another advantage of this imagery is that, because it is unclassified, it can be given to allies and coalition partners.

The spectral capabilities of these systems should not be forgotten. Since bands on the spectral imagers are similar to the French SPOT system, commercial imagery data should possess those capabilities associated with the SPOT system and should be able to provide the same products as the SPOT system. Capabilities such as terrain categorization, area delimitation, mission planning aids, mission visualization support, Camouflage, Concealment, and Deception (CCD) detection, and change detection should still be available.

Standardizing transmission formats of these data files presents a potential problem; however, it appears that this issue may have been avoided already. During preliminary discussions, corporations involved in the production and use of imagery products indicated they would agree to sell imagery and imagery related products in the National Imagery Transmission Format Standard (NITFS) to the USG. This allows imagery users in the DoD to use available, standard software to manipulate and disseminate imagery products derived from commercial sources.

Although commercial imagery is a new source of imagery, does not require extra training, handling, or systems. The basic imagery training, along with the lessons learned from spectral exploitation/application training, affords a solid foundation for using commercial imagery.

As mentioned previously, these corporations are looking to make a profit; hence, there are costs associated with using this imagery source. Someone will pay for each new image purchased. The situation determines who buys. Depending on the circumstances, it can be funded nationally or by a major command, a numbered Air Force, or even a wing. Moreover, the price will not be cheap. As a baseline, LANDSAT and SPOT images cost \$3500 and \$2500 respectively. While these costs may seem high, relative to launching and maintaining our own systems, they are quite low. In addition, the price depends on the contract the USG and these corporations sign. DoD's most cost-efficient method is to agree to a contract allowing the USG to buy an image one time, and make available to all USG users. This type of contract is more expensive for individual purchases, but far cheaper than buying the same frame several times. Another potential problem area is OPSEC. Arrangements must be made to protect the identity of the customer, as well as other information about the customer's purchase or collection request.

What is being done to help make this new source of imagery available to you? Currently, the Central Imagery Office (CIO) is attempting to answer the following three questions:

- 1) What is the utility of commercial imagery systems?
- 2) Do we want to integrate these systems into the U.S. Imagery System (USIS)?
- 3) If we do, how exactly will we go about doing it?

The CIO is currently looking at a “walk, run, sprint” concept of operations incorporating data from these systems as they become available and as technological advances allow the development of communication lines that can move the large data files typically associated with imagery products.

In the walk phase, users will search existing commercial archives at the Defense Intelligence Agency (DIA), is scheduled to be operational this summer, and at the Eros Data Center (EDC), Sioux Falls, SD. DIA retains copies of all commercial images purchased by the USG since 1995, while EDC holds only SPOT and LANDSAT images. These archives will be for images already purchased by the USG. Commercial vendors will put image metadata (descriptive information about the image) into the DIA archive. This way users are able to search for images collected, but not yet purchased, by the USG. If they find something matching their needs, they can buy the image through existing purchasing arrangements. Images will be distributed using courier or mail. This phase will not work well with time-sensitive requirements. Moreover, there is no provision to task assets for image collection. Since there are no technology hurdles to overcome, this walk phase could be in-place by 2002.

In the run phase, a “gateway,” serving as a central ordering desk and entry point for commercial images into the USIS, will be added to the archives of the walk phase. A user submits a request to the gateway, a vendor is selected, and the image digitally transferred back to the gateway for dissemination to the requester and the archives. Due to the electronic dissemination, time-sensitive requirements can be satisfied. If funding is available, this phase could also be in place by 2002.

The final phase, the sprint phase, involves a fully digital environment for the receipt and dissemination of commercial imagery. Imagery is downlinked directly to the gateway or deployed locations. In addition, this phase incorporates Global Broadcast System (GBS) technology. Implementation timelines are dependent upon funding and the state of GBS technology.

Many issues still need to be addressed and resolved. For example, how do we get images and imagery products to the flying unit level? What is the tasking process? Who pays and under what circumstances? Do we need or want a direct downlink-to-theater capability? Do we want to have the capability to directly task the payload from theater? Is a central tasking, receiving, and dissemination point (e.g. CIO, DIA, etc.) in the best interests of the Air Force? Obviously there are many questions still to be answered before the implementation of any plan.

CIO will be putting out a draft CONOPS on commercial imagery policy in 1996. All interested users should get a copy of this document. After reading the document, answer the following question: if commercial imagery can meet your unit’s needs, does the proposed concept of operations provide the best means of getting the imagery to your unit?

Land Data Satellites Currently Planned for the Next Decade

Country	Owner/ Mission	Program	Sched Date	Type	Resolution in Meters		#Color	Stereo	
					P	M		R	Bands
Canada	G/O	Radarsat	95	R			9		
India	G/O	IRS-1C	95	P&M	10	20		4	C/T
China/ Brazil	G/O	CBERS	95	P&M	20	20		7	C/T
Russia	G/O	Resource- 02	95	M		27		3	

U.S.	C/O	Earth Watch	96	P&M	3	15	3	F/A
U.S.	G/E	CTA/Clark	96	P&M	3	15	3	F/A
U.S.	G/E	TRW/ Lewis	96	P&M	5	30	384	
Russia	G/O	Almaz 2	96	R		5		
Japan	G/O	ADEOS	96	P&M	8	16	4	C/T
China/ Brazil	G/O	CBERS	96	P&M	20	20	7	C/T
U.S.	G/O	Eyeglass	97	P	1			F/A
France	G/O	Spot 4	97	P&M	10	20	4	C/T
U.S.	G/O	Earth Watch	97	P&M	1	4	4	F/A
U.S.	G/O	Space Imaging	98	P&M	1	4	4	F/A
Korea	G/O	KOM-SAT	98	P&M	10	10	3	F/A
U.S./Japan	G/O	EOS AM-1	98	M	15	15	14	F/A
U.S.	G/O	Landsat -7	98	P&M	15	30	7	
ESA	G/O	ENVI-SAT	98	R			30	0
France	G/O	Spot 5A	99	P&M	5	10	4	F/A
India	G/O	IRS-1D	99	P&M	10	20	4	C/T
France	G/O	Spot 5B	04	P&M	5	10	4	F/A
U.S.	G/O	EOS AM-2/L-8	04	P&M	10	30	7	

NOTES:

Multispectral Only - M

Operational - O

Government Funded - G

Pan & Multispectral - P & M

Experimental - E

Commercially Funded - C

Panchromatic Only - P

For & Aft Stereo - F/A

Radar - R

Cross-Track Stereo - C/T

SHIELD PHASE II CONTINUES SUCCESSFUL LEGACY

Christopher J. Fraser, Maj, SWC/XRV, DSN 560-9123

Mr. Sean D. McClung, DSN 560-9316

SHIELD Phase II continues to build upon the successful development methods which resulted in the Ballistic Missile Defense Organization's (BMDO) first project to achieve operational status. Located in the National Test Facility (NTF) at Falcon AFB, SHIELD receives and processes data from the entire constellation of Defense Support Program (DSP) satellites, and fuses it with data from a myriad of other sources such as Radio Detection and Ranging (RADAR), Signals Intelligence (SIGINT), airborne sensors, and national intelligence data. This data provides tactical units with a more accurate and timely warning of Theater Ballistic Missile (TBM) launch point, time, heading, and impact ellipse via theater broadcast communications networks.

Some of the sensors and sources successfully fused with DSP data include: the shipborne Cobra Judy RADAR, Aegis Spy-1 RADAR, the Big Safari Theater Airborne Warning System (TAWS), and the Miniature Sensor Technology Integration (MSTI)-2 satellite. The SHIELD project is the design, development, and demonstration effort benefiting the Army/Navy Joint Tactical Ground Station (JTAGS), the National Tactical Detection and Reporting (TACDAR) system, and the AF Attack and Launch Early Reporting to Theater (ALERT) programs.

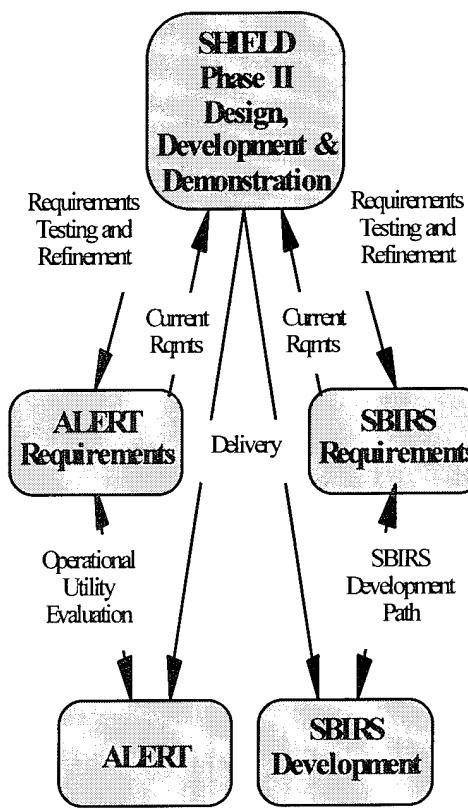


Figure 1 - SBIRS Pathfinder Flow

Continuing development efforts include:

- The cueing and fusion of RADARs and associated interceptors in support of Theater Missile Defense (TMD).
- Real-time processing and delimitation of multi-spectral imagery.
- Analysis of terrain and weather data for enhancement of launch point quality.
- Processing and fusion of Integrated Undersea Surveillance System (IUSS) data for counter cruise missile initiatives.
- Integration of national systems to provide enhanced, real-time data.
- Continued improvement of theater communications to support faster and more effective information dissemination.

When these capabilities reach a reasonable maturity level, they will be made available for contingency operations support. Ultimately these capabilities will be integrated into operational capabilities for the services. All of these efforts are transferable to National Missile Defense (NMD) applications as required.

Specific SHIELD Phase II efforts include:

- DSP processing improvements.
- D S P satelite parameter improvements.
- Integration of national sys-

tems with multiple DSP satellite data.

- Integration of RADAR sensor data with DSP data.
- Integration of MSTI data with multi-source data.
- TAWS development through Big Safari.
- Development of TALON SHIELD Tactical Terminal (TSTT) for real-time theater asset projection and allocation.
- Rehost of Composite Tactical Display (CTD)/ Generic Area Limitation Environment (GALE) to SiliconGraphics (SGI) platforms.
- Pathfinder analysis of accuracy requirements for Theater High Altitude Air Defense (THAAD) and Lightweight Exo-atmospheric Projectile (LEAP) interceptors.
- Pathfinder efforts for follow-on space-based warning capabilities, such as Space Based Infrared (SBIRS) and Space and Missile Tracking System (SMTS)

Other efforts include:

- Implementation of the Rapid Environmental Data Information (REDI) system for storage and real-time

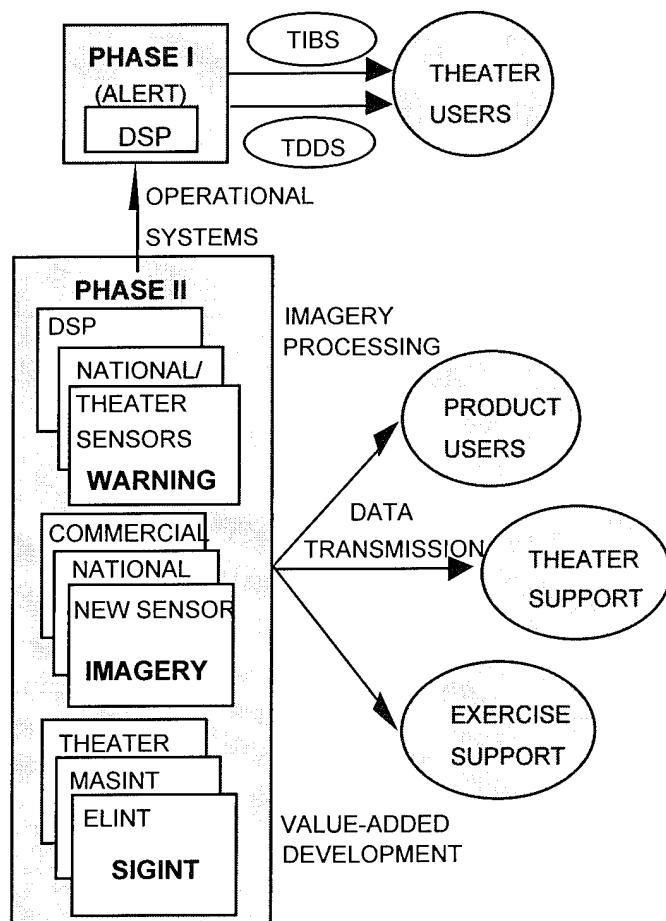


Figure 2 - SHIELD Phases I and II

processing of multi-source imagery.

- Enhancement of the Mapping, Earth Imagery, Weather Imagery Component (MEIWIC).
- Improvement of real-time weather information processing to delimit tactical location parameters.
- Support of Real-Time Information into the Cockpit (RTIC).
- Integration of automated subpixel processing into imagery capabilities.
- Exploitation of DSP Mission B data for added detection capabilities.
- Special event processing for Battlefield Damage Assessment (BDA).
- Exploration of RADAR interfaces.
- Theater defense cueing in cooperation with BMDO programs including MMIII/LEAP.
- BMC3 Element Support Center (BESC).
- Theater Missile Defense System Exerciser (TMDSE).

In addition, international projects are being explored with the United Kingdom, NATO, and other cooperative countries and alliances involving Cooperative Warning/Ballistic Missile Defense (BMD) architectures. Other developments include value-added experiments for full field-of-view strategic processing and exploration of support to space surveillance missions. Continuation efforts for FY97-98 and beyond will follow established objectives as identified in the *TALON SHIELD Phase II Project Plan* (18 Oct 95).

17TH TEST SQUADRON UPDATE

Capt Todd Gossett, 17 TS/TEO, DSN 560-9701

In the Fall 95 bulletin, we introduced the 17th Test Squadron, the new AFSPC organization responsible for planning, executing, and reporting Follow-on Operational Test and Evaluation (FOT&E) and command-directed test and evaluation of space systems. Since publication of that article, the squadron has achieved initial operational capability, and has grown and taken on several testing efforts.

The 17 TS grew from 25 personnel last fall to 76 as of 1 Jul 96. Several personnel joined the squadron's Test Operations, Tactics and Concepts, and Plans and Programs flights. Also, the squadron added a new flight of personnel assigned to assist Det 4, AFOTEC. The squadron is expected to reach its fully-manned status of 91 personnel later this year.

Along with the increase in the number of personnel has come an increase in the number of testing projects. Tactics and Concepts flight is managing an Operational Utility Evaluation (OUE) for the Advanced Technology Electronic Security System (ATESS) at Cape Canaveral AS, Florida. ATESS is an automated entry control/perimeter and interior intrusion detection system designed to upgrade security at Cape Canaveral. The flight is also involved in testing efforts for the Space Warfare Center's TENCAP and SPACECAP programs.

The Test Operations flight has taken on five testing efforts. It is managing a Qualification Operational Test and Evaluation (QOT&E) for the Perimeter Acquisition Radar Attack Characterization System (PARCS) recording subsystem upgrade. The upgrade is designed to improve data recording and transmission capabilities. Another test involves the DSP Mobile Ground System (MGS)/Milstar Integration at Holloman AFB, New Mexico, and Greeley ANGB, Colorado. The MGS/Milstar program adds survivable Milstar communications to the mobile missile warning system. The flight is also managing an operational test for the new Delta Launch Control Center currently under construction at Cape Canaveral. The new blockhouse combines administrative areas with a new launch control center for the Delta II launch vehicle. In addition, the flight will manage operational testing for a new launch pad at Vandenberg AFB, CA, to handle the Atlas II family of launch vehicles. Finally, the flight is overseeing operational testing for the Transportable Optical System (TOS). TOS is a deep space surveillance sensor being developed for the space surveillance mission.

The 17 TS Operating Location-Alpha (OL-A) at Cheyenne Mountain AS has also been very busy. In

January and June, OL-A conducted the Cheyenne Mountain end-to-end warning tests – the first occurrences of what will be semi-annual tests. Additionally, the OL-A will test two major vertical releases per year, as well as other upgrades and enhancements to the nation's warning system.

The Plans and Programs flight is developing a training and certification program for all new squadron personnel. The objective of the program ensures each squadron member is thoroughly familiar with testing philosophy, development, and conduct prior to managing an operational testing program. In addition, the flight is developing a time and money-saving tool to create combined test plans synthesizing Developmental Test & Evaluation (DT&E) with OT&E.

Most of the testing efforts in the 17 TS are supported by our Analysis flight. This flight actively supports the ATESS testing program and assists all other 17 TS testing efforts with test planning. To support the various testing efforts, the Analysis flight increased its resources by obtaining new software tools and support agreements with AFOTEC analysis centers.

As you can see, the 17 TS is charging ahead with testing efforts in all space mission areas. The future promises many more testing programs to tackle as the 17 TS continues to live up to its motto, "Testing for Warfighters." For more information, contact Lt Col Carl Cox, 17 TS/CC, DSN 560-9701.

OPPORTUNITIES AND CHALLENGES IN THE MILITARY USE OF COMMERCIAL SPACE IMAGERY

Geoff Goodman, BETAC Contractor, DSN 560-9181

During Desert Storm, broad area coverage from remote sensing satellites was used for map updates, battlefield orientation, and cross country movement analysis, whereas high resolution coverage was used to analyze targets and support battle damage assessment. However, the imagery available from airborne and spaceborne platforms could not meet the demands of 1000+ combat air sorties per day and the rapidly changing tactical situation on the ground. A comparable shortfall existed in military communications satellite capacity to meet Desert Storm requirements. Fortunately, commercial communications satellites were available for lease to meet shortfalls in military systems. In the future we expect the growing capabilities in commercial imagery systems to fill similar shortfalls in the need for imagery coverage in the area of operations. Just as they incorporated commercial communications satellites into an overall communications architecture, the US military needs to incorporate commercial imagery satellites into a comprehensive imagery architecture.

During the five years since Desert Storm, the number of commercial imagery satellite systems with military potential has exploded. As Figure 1 illustrates, the field of commercial imagery satellites is expanding rapidly throughout the world. Over the next several years, many new systems will be placed in orbit, promising enhanced multi-spectral and panchromatic imagery down to one meter resolution. This means capabilities previously provided by national systems will become available on the commercial market.

Opportunities

It is apparent the US is entering an era of greater opportunities in satellite imagery. An obvious opportunity will be the increased availability of imagery. The presence of more operational systems means more imagery coverage will be available and collection opportunities for a specific point on earth occurs more frequently.

Commercial imagery technology is approaching existing national systems capabilities. Some of these new commercial imagery systems can augment the imagery support provided by national systems, freeing national assets to satisfy other critical requirements. For example, Canadian Radarsat (launched in early November 1995) and NASA's Clark imaging system (scheduled for launch this summer) have the potential to provide high resolution imagery for targeting, mission planning, and battle damage assessment.

In addition, the increasing number of advanced commercial imagery satellites can act as a backup in case of technical failures, including failures of national assets. During situations when imagery requirements increase dramatically, such as combat and contingency operations, commercial satellites can provide a surge capability by augmenting those systems already in use. Moreover, the broadening spectrum of commercial imagery systems (e.g. panchromatic, multi-spectral, and radar) provides improved opportunities for selecting the most appropriate sensor for the situation.

Challenges

There are many challenges associated with the growth in commercial imagery systems. For example, it has been difficult enough in the past to decide which tactical and national imagery systems to use in a given situation. With additional commercial imagery systems, the process of deciding which system to task or which

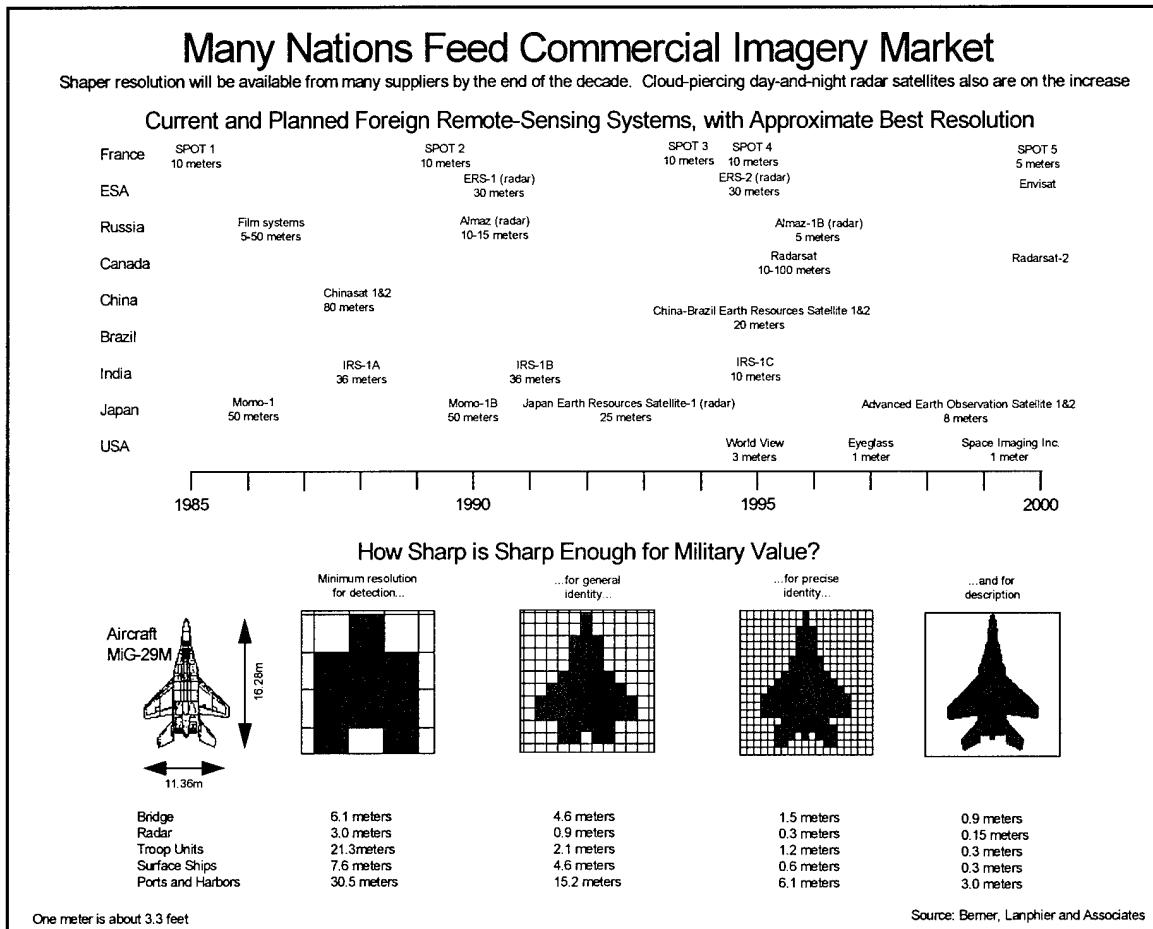


Figure 1

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historical image to acquire could become even more complex.

Before commercial imagery systems can be used effectively, several tasks must be accomplished. Rigorous, comparative testing and analysis of imagery from commercial and national systems must be completed. This analysis provides a manageable subset of commercial systems offering real utility for military purposes.

One of the challenges of imagery processing and dissemination is providing an effective technical architecture with the required responsiveness and throughput. Commercial imagery systems have their own architectures with nodes, links, and standards different from national systems. To insert the commercial data, we must find common data formats, compatible communications, and some appropriate node in the U.S. military system

insert the data. Projects such as Eagle Vision, National Eagle, and DATARAM are aimed at solving some of the technical problems associated with using commercial imagery for military purposes.

Another difficulty associated with the military use of commercial imagery is there are no comprehensive procedures for operational use of commercial imagery. Such procedures are necessary to integrate imagery tasking, acquisition of imagery data, image processing, and dissemination of commercial imagery with corresponding procedures for tactical and national imagery. At the heart of these procedures would be guidelines for making trade-off decisions between tasking national, tactical, or commercial systems in a given situation. Developing such procedures is a formidable task because the U.S. Government cannot exercise the same level of control over commercial space system that it exercises over its own assets. Moreover, in the case of foreign-owned and operated satellites, the U.S. has even less control. U.S. companies are more interested in selling data and products than in relinquishing control of their satellites. Developing procedures requires a U.S. Government organization (or organizations) to serve as a central control, or management, point for imagery requirements and make the following determinations:

- Which requirements can be satisfied by commercial imagery?
- Does satisfactory commercial imagery already exist, and if so, from what system or systems?
- Has the U.S. Government already purchased the imagery?
- Where does the imagery reside, and how will it be transmitted to the end user?
- If the imagery must be collected, what is the best system to use and when is the next good collection opportunity?
- Where will the imagery data be downlinked and how will it be transmitted to the end user?

Since these questions will have to be answered for every imagery request, and since many imagery requests need to be satisfied simultaneously, this process has the potential to be very complicated. The Space Warfare Center is working with several government organizations, including the Defense Intelligence Agency, the Defense Mapping Agency, and the Central Imagery Office, to develop procedures and technical architectures to answer these questions. Once these challenges are overcome, commercial space imagery systems will achieve a new level of military utility.

SPACE 101 - PRINCIPLES OF SPACE OPS

Capt David M. Malinowski, SWC/DOT, DSN 560-8348

Welcome to the continuation of Space 101. In the Winter 95 bulletin, we covered the principles of spacelift. Since it is fairly uncommon for a satellite to be launched directly into its final, desired orbit, this article focuses on orbital maneuvers.

Satellite orbits are basically stable and predictable. This stability is often an advantage, but can be restrictive. Space operations, such as resupply, rendezvous, and interception, sometimes require orbits to be changed. In addition, a new satellite often is maneuvered into its operational orbit. The purpose of an orbit maneuver is to

change one or more of the parameters of the orbital element set. The two basic categories of on-orbit maneuvers are the in- and out-of-plane maneuvers.

An in-plane maneuver usually changes the size (semi-major axis and period) or shape (eccentricity) of an orbit (see Figure 1).

The most common in-plane maneuver is the Hohmann transfer (see Figure 2). This transfer adjusts the

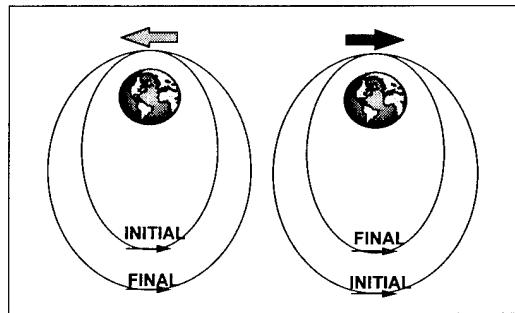


Figure 1 - In plane Manuver

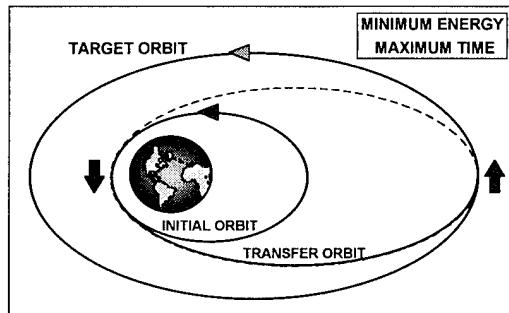


Figure 2 - Hohmann Transfer

semi-major axis of an orbiting satellite. The method requires the minimum amount of energy to perform the desired orbit change. The greatest amount of payload is placed into the target orbit for the least amount of propellant. The drawback to this maneuver is it takes the maximum transfer time between the two orbits (normally hours).

If the Hohmann Transfer is not fast enough to meet mission objectives, then another method, known as the high energy or fast transfer, can be used (see Figure 3). The advantage is it does not take as much time as the Hohmann transfer; the disadvantage is it requires more energy and propellant. Operationally, a trade-off must be made between payload weight and propellant weight. Out-of-plane maneuvers result in a change of the orbital plane. The most frequent out-of-plane maneuver changes inclination without changing any other parameter. To accomplish this, the plane change must occur at a point common to both orbits. In this case, is completed at the ascending or descending node (see Figure 4). If completed at any other point, the resulting orbit will have a different Right Ascension of the Ascending Node.

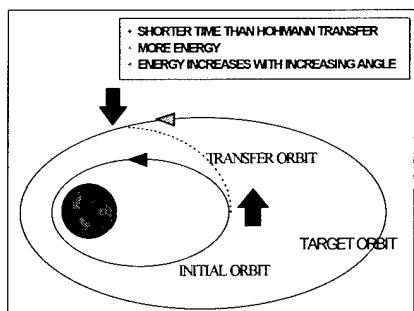


Figure 3 - Fast Transfer

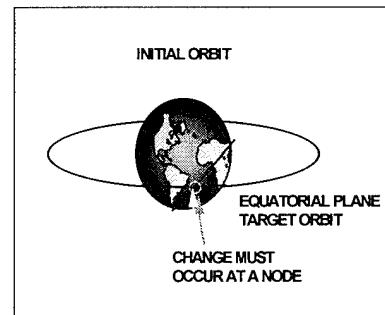


Figure 4 - Plane Change

If this short article has piqued your interest about space, we welcome you to our two day Space and Missile Applications Basic Course where you can learn more space fundamentals, covering the entire range of space applications. Just call our friendly registrars at DSN 560-9640/9645.